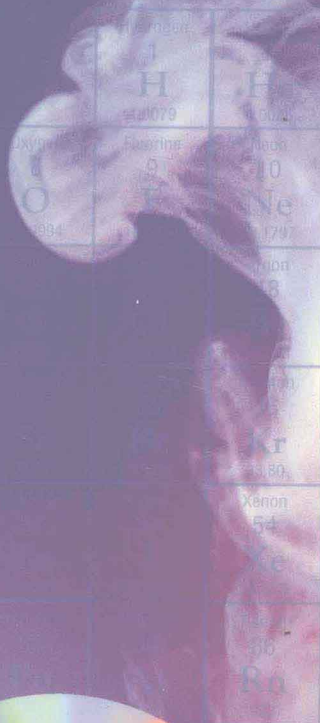


Chemistry

& Chemical Reactivity



Hydrogen 1 H 1.0079	Helium 2 He 4.0026
Lithium 3 Li 6.941	Boron 5 B 10.81
Beryllium 4 Be 9.0122	Carbon 6 C 12.011
Nitrogen 7 N 14.007	Oxygen 8 O 15.999
Fluorine 9 F 18.998	Neon 10 Ne 20.180
Sodium 11 Na 22.990	Magnesium 12 Mg 24.305
Aluminum 13 Al 26.982	Silicon 14 Si 28.086
Phosphorus 15 P 30.974	Sulfur 16 S 32.06
Chlorine 17 Cl 35.453	Argon 18 Ar 39.948
Potassium 19 K 39.098	Calcium 20 Ca 40.078
Scandium 21 Sc 44.956	Titanium 22 Ti 47.88
Vanadium 23 V 50.942	Chromium 24 Cr 51.996
Manganese 25 Mn 54.938	Iron 26 Fe 55.845
Cobalt 27 Co 58.933	Nickel 28 Ni 58.69
Copper 29 Cu 63.546	Zinc 30 Zn 65.38
Gallium 31 Ga 69.723	Germanium 32 Ge 72.64
Arsenic 33 As 74.922	Selenium 34 Se 78.96
Bromine 35 Br 79.904	Krypton 36 Kr 83.80
Strontium 38 Sr 87.62	Yttrium 39 Y 88.906
Zirconium 40 Zr 91.224	Niobium 41 Nb 92.906
Molybdenum 42 Mo 95.94	Ruthenium 44 Ru 101.07
Rhodium 45 Rh 102.91	Palladium 46 Pd 106.42
Silver 47 Ag 107.87	Cadmium 48 Cd 112.41
Mercury 80 Hg 200.59	Thallium 81 Tl 204.38
Lead 82 Pb 207.2	Bismuth 83 Bi 208.98
Polonium 84 Po [209]	Astatine 85 At [210]
Francium 87 Fr [223]	Radium 88 Ra [226]

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THIRD EDITION

Annotated Instructor's Edition

**Preview
Book**



Chemistry & Chemical Reactivity

T h i r d E d i t i o n

Available July 1995
Guaranteed for Fall Classes!

**Kotz &
Treichel**

ABBREVIATED PREFACE

This is the *Third Edition of Chemistry & Chemical Reactivity*. Although some years have passed since the book was first conceived, the principal theme has remained the same: to provide a broad overview of the principles of chemistry and the reactivity of chemical elements and compounds. We also hope to convey a sense of chemistry as a field that not only has a lively history but also one that is currently dynamic, with important new developments on the horizon. In addition, we want to provide some insight into the chemical aspects of the world around us. For example, what materials are important to our economy, how does chemistry contribute to health care, and what role do chemists play in protecting the environment? By tackling the principles leading to answers to these questions, you can come to a better general understanding of nature and gain an appreciation for some of the consumer products coming from the chemical industry. Indeed, one of the objectives of this book is to provide the tools and background information for you to function as an informed citizen in a technologically complex world. Learning something of the chemical world is as important as understanding some basic mathematics and biology, and just as important as having an appreciation for fine music and literature.

We are also very excited by the fact that this is the first chemistry textbook to be offered on a CD-ROM (compact disc-read-only memory). Computers have become a more and more powerful way to organize and convey information, and our CD-ROM is the first attempt to deliver that to students. Not only is the actual text book—with all the photos and figures—available on the CD-ROM, but the material in each chapter is presented in an interactive manner. In addition, there are mathematical and molecular modeling tools, and an illustrated database of compounds and their properties. The disc is meant to be an individual learning tool. Therefore, it is available for purchase with the textbook or as a stand-alone product. The contents of the disc are outlined in more detail below.

The authors of this book became chemists because, simply put, it is exciting to discover new compounds and find new ways to apply chemical principles. We hope to convey our enjoyment of chemistry in this book as well as our awe at what is known about chemistry and, just as important, what is not known!

Philosophy and Approach of the Book

When the first edition of this book was planned, we had two major, but not independent, goals. This edition has these same goals. The first was to construct a book that students would enjoy reading and that would offer, at a reasonable level of rigor, chemistry and chemical principles in a format and organization typical of college and university courses today. Second, we wanted to convey the utility and importance of chemistry by introducing the properties of the elements, their compounds, and their reactions as early as possible and by focusing the discussion as much as possible on these subjects.

A glance at the introductory chemistry texts currently available shows that there is a generally common order of treatment of chemical principles

used by educators. With a few minor changes we have followed that order. That is not to say that the chapters cannot be used in some other order. For example, although the behavior of gases is often studied early in a chemistry course, the chapter on this topic (Chapter 12) has been placed with chapters on liquids, solids, and solutions because it logically fits with these other topics. It can easily be read and understood, however, after covering only the first four or five chapters of the book.

The discussion of organic chemistry (Chapter 11) is typically left to one of the final chapters in chemistry textbooks. We believe, however, that the importance of organic compounds in biochemistry and in the chemical industry means that we should present that material earlier in the sequence of chapters. Therefore, it is placed in the middle of the book, following the chapters on structure and bonding. This position was chosen because the principles of structure and bonding are particularly well illustrated by organic compounds. In any event, this chapter could be covered at almost any point in the book.

In addition, one of the authors of this text sometimes teaches the material on equilibria involving insoluble solids (Chapter 19) before acid-base equilibria (Chapters 17 and 18), and introduces kinetics (Chapter 15) and thermodynamics (Chapter 20) as a unit, after all of the material on equilibria. Although chapters are loosely organized into groups with common themes, every attempt has been made to make the chapters as independent as possible.

The order of topics in the text was also devised to introduce as early as possible the background required for the laboratory experiments usually done in General Chemistry. For this reason, chapters on common reaction types (especially acid-base and oxidation-reduction reactions, Chapter 4) and stoichiometry (Chapter 5) begin the book. In addition, because an understanding of energy is so important in the study of chemistry, thermochemistry is introduced in Chapter 6.

The American Chemical Society has been urging educators to put “chemistry” back into introductory chemistry courses, and we agree wholeheartedly. Therefore, we have tried to describe the elements, their compounds, and their reactions as early and as often as possible in three ways. First, there are numerous color photographs of reactions occurring, of the elements and common compounds, and of common laboratory operations and industrial processes. Further, we have tried to bring material on the properties of elements and compounds as early as possible into the Exercises and Study Questions and to introduce new principles using realistic chemical situations. Additionally, there are sections called Current Issues in Chemistry that discuss such topics as the effects of chlorine-containing compounds in the environment (Chapter 2), buckyball chemistry (Chapter 3), the chemistry of black smokers (Chapter 4), the disposal of industrial wastes (Chapter 5), the use of hydrogen as a fuel (Chapter 6), the chemistry of NO (Chapter 9), the use of supercritical fluids to make plastics (Chapter 13), and surviving at sea (Chapter 14).

Organization of the Book

Chemistry & Chemical Reactivity is organized in two ways. First, there are chapters that are especially important in carrying the themes of the book. That is, there are chapters on the Principles of Reactivity, and there are others on Bonding and Molecular Structure.

The chapters on Principles of Reactivity are intended to introduce you to the factors that lead chemical reactions to be successful in producing products. Thus, under this topic you will study common types of reactions, the energy involved in reactions, and the factors that affect the speed of a reaction.

The principles of Bonding and Molecular Structure are particularly important. If you page through the book you will notice the abundance of molecular models, both ones done by George Kelvin, our artist for this edition, and by computer. As described in several places in the book (An Introduction—The Nature of Chemistry; Chapter 3: Buckyballs, AIDS, and Chemistry; and Chapter 9: Computer Molecular Modeling) an understanding of molecular structures is one cornerstone of modern chemistry. Using the latest laboratory techniques for uncovering molecular structures, and computer programs that generate revealing portraits of structures, chemists have enormous insight into the ways molecules react.

The book is also divided roughly into five sections, each with a grouping of chapters with a common theme.

Part 1: The Basic Tools of Chemistry

Certain basic ideas and methods form the fabric of chemistry, and these are introduced in Part 1. Chapter 1 defines some important terms and is a review of units and mathematical methods. Chapters 2 and 3 introduce some basic ideas of atoms and molecules, and Chapter 2 introduces the periodic table, one of the most important resources available to chemists. In Chapters 4 and 5 we begin to discuss some principles of chemical reactivity and to introduce the numerical methods used by chemists to extract quantitative information from chemical reactions. Chapter 6 is the first introduction to the energy involved in chemical processes.

Part 2: The Structure of Atoms and Molecules

The major goal of this section is to outline (Chapters 7 and 8) the current theories of the arrangement of electrons in atoms and some of the historical developments that led to these ideas. With this background, we can understand why atoms and their ions have different chemical and physical properties. This discussion is tied closely to the arrangement of elements in the periodic table so that these properties can be recalled and predictions made. In Chapter 9 we discuss for the first time how the electrons of atoms in a molecule may lead to chemical bonding and the properties of these bonds. In addition, we show how to derive the three-dimensional structure of simple molecules. Finally, Chapter 10 considers two of the major theories of chemical bonding in more detail.

This part of the book is completed with a discussion of organic chemistry. Organic chemistry is such an enormous area of chemistry that we cannot hope to cover it in detail in this book. We have chosen to focus on the structures of compounds, and on compounds of particular importance such as synthetic polymers.

Part 3: States of Matter

The behavior of the three states of matter — gases, liquids, and solids — is described in that order in Chapters 12 and 13. The discussion of liquids and solids is tied to gases through the description of intermolecular forces, with particular attention given to liquid and solid water. Chapter 13 also considers the solid state, an area of chemistry currently undergoing a renaissance. In Chapter 14 we talk about the properties of solutions, intimate mixtures of gases, liquids, and solids.

Part 4: The Principles of Reactivity

This section is wholly concerned with the Principles of Reactivity. Chapter 15, examines the important question of the rates of chemical processes and the factors controlling these rates. With this in mind, we move to Chapters 16 through 19, a group of chapters that considers chemical reactions at equilibrium. After an introduction to equilibrium in Chapter 16, we highlight the reactions involving acids and bases in water (Chapters 17 and 18) and reactions leading to insoluble salts (Chapter 19). To tie together the discussion of chemical equilibria, we again explore thermodynamics in Chapter 20. As a final topic in this section we describe in Chapter 21 a major class of chemical reactions, those involving the transfer of electrons, and the use of these reactions in cells that produce a voltage.

Part 5: The Chemistry of the Elements and Their Compounds

Although the chemistry of the various elements is described throughout the book, Part 5 considers this topic in a more systematic way. Chapter 22 is devoted to the chemistry of the representative elements, while Chapter 23 is a discussion of the transition elements and their compounds. Finally, Chapter 24 is a brief discussion of nuclear chemistry.

Philosophy and Approach of the CD-ROM

We have designed the CD-ROM to take advantage of what computers do best: allow the user to interact with information. Therefore, our goal was to produce an interactive multimedia alternative. The material in each chapter is presented in a series of “screens,” each of which presents an idea or concept and allows the user to interact with the information in some manner—by seeing video of a reaction in progress, by changing a variable in a chemical experiment and watching what happens to the system, or by listening to important tips and ideas about ways to understand a concept or solve a problem. In addition, you will see practicing chemists describe how the topic of the chapter applies to their work.

To make the CD-ROM even more useful, the text of the actual book is also present, with all the photos and figures. Therefore, you will be able to study the material using the interactive presentation, and you can find the most pertinent section of the book with the click of a mouse. If you need information on a compound, tools will allow students to simulate actual experiments, further enhancing comprehension of the material. A bookmark will help you use the interactive presentation of the book.

The combination of an interactive presentation of chemistry, coupled with the text of the actual book and other tools for doing chemistry, means that the CD-ROM provides a complete learning environment. Therefore, depending on your needs, and the availability of computer facilities, you may purchase only the book, only the CD-ROM with its workbook, or both the book and the CD-ROM.

FEATURES

The third edition of this bestseller continues to provide a strong comprehensive overview of chemistry principles and the reactivity of chemical elements and compounds, while sparking an interest in the significance of chemistry to the economy, the environment, health care—in short, to life.

Writing Style and Currency

► The authors friendly writing style gently eases students into the principles of chemistry, while providing current and interesting applications to increase the students interest in science.

Reactivity as a Running Theme

► Highlighted chapters and a colorful art program reinforce the idea that chemistry is a dynamic and reactive science.

Topical Interviews

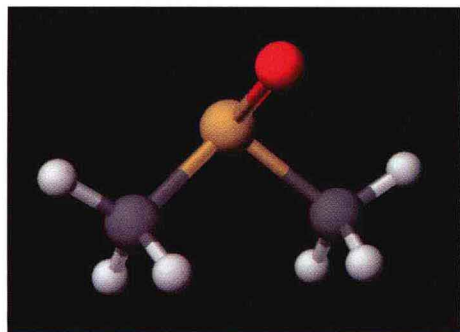
► An emphasis on the significance of science and, particularly, chemistry, is apparent in interviews with well-know scientists on topics such as science and its future, science careers, and science education.

Plentiful Pedagogy

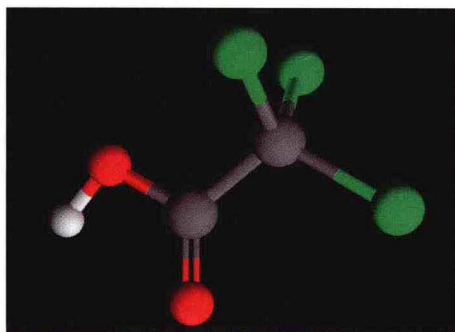
Students benefit from pedagogy that includes:

► Problem-Solving Tips and Ideas, “A Closer Look” boxed essays, margin notes, worked examples exercises and conceptual flow diagrams within a chapter.

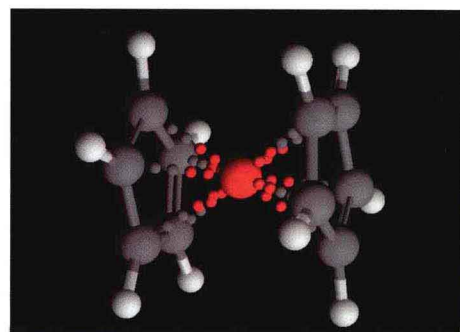
► Chapter Highlights, summary questions linking current chapter concepts to those in previous chapters; chapter-end study questions that are often accompanied by photographs; and several hundred worked examples that aid in solving chapter-end problems.



Computer generated model of dimethyl sulfoxide.



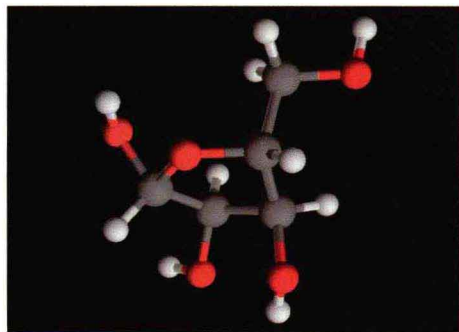
Computer-generated model of trichloroacetic acid.



Computer-generated model of ferrocene.

NEW TO THIS EDITION

The third edition of *Chemistry & Chemical Reactivity*, paired with the innovation behind the *Saunders Interactive CD-ROM for General Chemistry*, is an incomparable blend of technology, knowledge, and useful, enjoyable chemistry. The authors were determined that this revision incorporate the tools and chemistry foundation necessary for students to function in a technologically sophisticated world. With *Chemistry & Chemical Reactivity*, 3/e, they have admirably met their goal.



Computer-generated model of β -D-ribose.

Saunders CD-ROM for General Chemistry

► An unparalleled, revolutionary CD-ROM accompanies the text, providing students with the text on disk; extensive interactive capabilities; mathematical and molecular modeling tools; and an illustrated database of compounds (*see separate "CD-ROM" description*).

Improved Organization

► A more cohesive presentation of chemical reactions and stoichiometry (Chapters 4 and 5 respectively) gives students the necessary background required for laboratory experimentation.

► An early discussion of organic chemistry (Chapter 11), which stresses the importance of organic compounds in biochemistry and the chemical industry, immediately follows chapters on structure and bonding to clarify and apply the principles of these topics.

More Conceptual Problem-Solving

► A greater emphasis on conceptual problem solving includes "Problem Solving Tips and Ideas" sections that target common errors and difficulties; revised examples integrated throughout the text; flow diagrams to immerse students in essential critical-thinking activities and a dedicated section of conceptual problems at the end of each chapter.

State-of-the-Artwork

► A refined art program features unsurpassed, color-coded molecular models, pedagogical use of color in periodic tables, and more than 600 full-color photos.

Sharper Focus on Diversity

► High-interest "Portrait of a Scientist," "Current Issues in Chemistry," and "Interviews with Chemists" sections emphasize diversity with an increased focus on the contributions of women and minorities to the field of chemistry.

A New Start

► A new Introduction emphasizes the dynamic, applicable nature of chemistry, giving students insight into numerous areas of study.

TABLE OF CONTENTS

INTRODUCTION: THE NATURE OF CHEMISTRY

A brief discussion about the importance of science, in general, and chemistry, in particular, through the use of understanding molecular structure and its consequences for chemical reactivity.

- Science and Its Methods
- Simple But Elegant Experiments
- Model Building, Science, and Molecular Structure
- Why Care About Chemistry
- Risks and Benefits

CHAPTER 1 MATTER AND MEASUREMENT

Fundamental ideas are introduced as needed rather than within a drill-oriented foundation. The chapter begins with a discussion of the physical properties of substances and the kinetic molecular theory and closes with numerical problem solving.

- 1.1 Physical Properties
 - Problem Solving Tips and Ideas 1.1: Finding Data
- 1.2 Elements and Atoms
- 1.3 Compounds and Molecules
 - Current Issues in Chemistry: Gold Made by Bacteria?
- 1.4 Chemical and Physical Changes
- 1.5 Mixtures and Pure Substances
- 1.6 Units of Measurement
 - Problem Solving Tips and Ideas 1.2: Using Scientific Notation
- 1.7 Using Numerical Information
 - Problem Solving Tips and Ideas 1.3: Problem Solving Strategies

CHAPTER 2 ATOMS AND ELEMENTS

Material on atomic structure has been moved to Chapter 7.

- 2.1 Origins of Atomic Theory
 - Portrait of a Scientist: John Dalton
- 2.2 Atomic Structure
 - Portrait of a Scientist: Marie Curie
 - Portrait of a Scientist: Ernest Rutherford
- 2.3 Atomic Composition
- 2.4 Isotopes
- 2.5 Atomic Mass
 - Problem Solving Tips and Ideas 2.1: Calculating Your Grade or an Atomic Mass
- 2.6 The Periodic Table
 - Portrait of a Scientist: Dmitri Ivanovitch Mendeleev

Introduction of the Periodic Table includes an outline of its more important features and a brief historical perspective of its development.

- 2.7 The Mole - The Macro/Micro Connection
 - Current Issues in Chemistry: Banning Chlorine
 - Portrait of a Scientist: Amedeo Avogadro and His Number
 - Problem Solving Tips and Ideas 2.2: More on Unit Conversions

CHAPTER 3 MOLECULES AND COMPOUNDS

- 3.1 Elements that Exist as Molecules
 - Current Issues in Chemistry: Bucky Balls, AIDs, and Modern Chemistry
- 3.2 Molecular Compounds
- Sections 3.1 and 3.2 have been revised extensively.*
- 3.3 Ions
- 3.4 Ionic Compounds
 - A Closer Look: Ionic Compounds and Coulomb's Law
 - Problem Solving Tips and Ideas 3.1: Formulas for Ions

and Ionic Compounds

- Portrait of a Scientist: Michael Faraday

Section 3.3 from the previous edition has been split into two new sections to provide greater depth of coverage of ions and ionic compounds.

- 3.5 Names of Compounds
 - Inclusion of selected hydrocarbons increases the number of substances that can be used in examples of real-world applications.*
- 3.6 Molecules, Compounds, and the Mole
- 3.7 Describing Compound Formulas
 - Problem Solving Tips and Ideas 3.2: Finding Empirical and Molecular Formulas
 - Problem Solving Tips and Ideas 3.3: Finding Empirical and Molecular Formulas
- 3.8 Hydrated Compounds
 - Completely new section provides nomenclature worked examples and the details needed to discuss hydrated compounds.*

INTERVIEW: JAMES A. CUSUMANO

James Cusumano loved chemistry and music since he was a young boy in New Jersey. After working as a musician and writing successful songs (such as "Short Shorts Twist"), he completed his Ph.D. in chemistry and worked in industry. He is the co-founder and president of Catalytica, a California company whose goal is to prevent environmental pollution through new chemistry. Portions of his interview will also appear on the CD-ROM interactive version of this textbook.

CHAPTER 4 PRINCIPLES OF REACTIVITY: CHEMICAL REACTIONS

A more cohesive organization includes a clearer discussion of chemical reactions and a later discussion of combination and decomposition reactions. The types of reactions presented have been reorganized around reactions in aqueous solution: precipitation, acid-base, and gas-forming reactions. Material on balancing redox reactions has been moved to Chapter 21, Electrochemistry.

- 4.1 Chemical Equations
 - Added section carefully introduces the terms and definitions of chemical equations.*
 - Portrait of a Scientist: Antoine Laurent Lavoisier
- 4.2 Balancing Chemical Equations
- 4.3 Properties of Compounds in Aqueous Solutions
 - A Closer Look: Soluble or Insoluble: Why Is It Important?
- New boxed essay explains the importance of distinguishing soluble from insoluble materials.*
- 4.4 Acids and Bases
 - A Closer Look: H^+ Ions in Water
- New boxed essay defines which form of the hydronium ion the authors will use and why.*
- 4.5 Equations for Reactions in Aqueous Solution: Net Ionic Equations
 - New section indicates the importance of net ionic equations.*
- 4.6 Types of Reactions in Aqueous Solution
- 4.7 Precipitation Reactions
- 4.8 Acid-Base Reactions
 - Current Issues in Chemistry: Black Smokers
- 4.9 Gas-Forming Reactions
 - Problem Solving Tips and Ideas 4.1: A Common Theme for Reactions in Aqueous Solution
- 4.10 Oxidation-Reduction Reactions

CHAPTER 5 STOICHIOMETRY

A combination of Sections 4.4-4.7 and Section 5.4 from the previous edition creates this new chapter, resulting in stronger coverage of the quantitative aspects of chemical reactions.

- 5.1 Weight Relations in Chemical Reactions: Stoichiometry
 - Problem Solving Tips and Ideas 5.1: Stoichiometry Calculations
- 5.2 Reactions in Which One Reactant is Present in Limited Supply
 - Problem Solving Tips and Ideas 5.2: A “Real-Life” Analogy to a Limiting Reactant Problem in Chemistry
 - Portrait of a Scientist: Barnett Rosenberg and Platinum Compounds for Cancer Treatment
 - Problem Solving Tips and Ideas 5.3: Reactions Involving a Limited Reactant
 - Problem Solving Tips and Ideas 5.4: Reactions Involving a Limiting Reactant
- 5.3 Percent Yield
- 5.4 Chemical Equations and Chemical Analysis
- 5.5 Working with Solutions
 - Problem Solving Tips and Ideas 5.5: Making a Solution by Dilution
 - Problem Solving Tips and Ideas 5.6: Moles, Volume, and Molarity
- 5.6 Stoichiometry of Reactions in Aqueous Solution
 - Problem Solving Tips and Ideas 5.7: Stoichiometry Calculations Involving Solutions
 - Current Issues in Chemistry: Where Do Industrial Wastes Go?

CHAPTER 6 PRINCIPLES OF REACTIVITY: ENERGY AND CHEMICAL REACTIONS

- 6.1 Energy: Its Forms and Units
 - A Closer Look: Why Doesn't the Heat in a Room Cause Your Cup of Coffee to Boil?
- 6.2 Heat Capacity and Thermal Energy Transfer
 - Portrait of a Scientist: James P. Joule
 - Portrait of a Scientist: Joseph Black
 - A Closer Look: Sign Conventions in Energy Calculations
 - Problem Solving Tips and Ideas 6.1: Calculating ΔT
 - Problem Solving Tips and Ideas 6.2: Units of Specific Heat Capacity
 - Problem Solving Tips and Ideas 6.3: Using the Concept of Energy Conservation
- 6.3 Energy and Changes of State

A new section introduces the concepts of heat of fusion and the heat of vaporization.

- 6.4 Enthalpy
 - A Closer Look: Internal Energy
- 6.5 Enthalpy Changes for Chemical Reactions
 - Current Issues in Chemistry: MRE's Are Heated in the FRH
- 6.6 Hess's Law
- 6.7 State Functions
- 6.8 Standard Enthalpies of Formation
 - A Closer Look: Hess's Law and Equation 6.6
- 6.9 Determining Enthalpies of Reaction

New Sections 6.8 and 6.9 provide a more organized introduction to two important thermochemical concepts.

- 6.10 Applications of Thermodynamics

This new section applies thermochemistry to real-world problems.

- Current Issues in Chemistry: The Hydrogen Economy

CHAPTER 7 ATOMIC STRUCTURE

Revised chapter combines the previous edition's atomic structure chapter with selected material from Chapter 2, “Atoms and Elements,” to

present the principles of atomic structure within a framework of descriptive and historical information.

- 7.1 Electromagnetic Radiation
- 7.2 Planck, Einstein, Energy, and Photons
 - Portrait of a Scientist: Max Planck
 - Problem Solving Tips and Ideas 7.1: Energy, Frequency, and Wavelength
- 7.3 Atomic Line Spectra and Niels Bohr
 - Portrait of a Scientist: Niels Bohr
 - A Closer Look: Experimental Evidence for Bohr's Theory
- 7.4 The Wave Properties of the Electron
 - A Closer Look: de Broglie and Electron Microscopes
- 7.5 The Wave Mechanical View of the Atom
 - A Closer Look: Heisenberg's Uncertainty Principle
- 7.6 The Shapes of Atomic Orbitals
 - A Closer Look: Orbital Shapes and Spherical Nodes

CHAPTER 8 ATOMIC ELECTRON CONFIGURATIONS AND CHEMICAL PERIODICITY

Students develop an understanding of the electronic structure of the elements beyond hydrogen and explore some of the physical properties of atoms.

- 8.1 Electron Spin
 - A Closer Look: Paramagnetism and Ferromagnetism
- 8.2 The Pauli Exclusion Principle
- 8.3 Atomic Subshell Energies and Electron Assignments
 - Portrait of a Scientist: Lise Meitner
- 8.4 Atomic Electron Configurations
- 8.5 Electron Configurations of Ions
- 8.6 Atomic Properties and Periodic Trends
- 8.7 Chemical Reactions and Periodic Properties

CHAPTER 9 BONDING AND MOLECULAR STRUCTURE: FUNDAMENTAL CONCEPTS

- 9.1 Valence Electrons
 - Portrait of a Scientist: Gilbert Newton Lewis
- 9.2 Chemical Bond Formation
- 9.3 Covalent Bonding
 - Problem Solving Tips and Ideas 9.1: Drawing Resonance Structures
 - Current Issues in Chemistry: NO is no Dud!
 - Problem Solving Tips and Ideas 9.2: Drawing Lewis Electron Dot Structures
- 9.4 Bond Properties
 - A Closer Look: Electronegativity - A New View
 - Portrait of a Scientist: Linus Pauling
 - A Closer Look: Atom Partial Charges
- 9.5 Molecular Shape
 - Current Issues in Chemistry: Computer Molecular Modeling
 - Problem Solving Tips and Ideas 9.3: Determining Molecular Structure
- 9.6 Molecular Polarity
 - Portrait of a Scientist: Peter Debye
 - A Closer Look: Cookin' with Polar Molecules

CHAPTER 10 BONDING AND MOLECULAR STRUCTURE: ORBITAL HYBRIDIZATION, MOLECULAR ORBITALS, AND METALLIC BONDING

- 10.1 Valence Bond Theory
 - A Closer Look: Chemical Bonds and Vision
 - Problem Solving Tips and Ideas 10.1: Hybrid Orbitals
- 10.2 Molecular Orbital Theory
 - A Closer Look: Molecular Orbitals for Compounds Having *p*-Block Elements
- 10.3 Metals and Semiconductors

CHAPTER 11 BONDING AND MOLECULAR STRUCTURE: ORGANIC CHEMISTRY

New chapter applies the principles of bonding and structure developed in the previous two chapters and introduces organic chemistry. A completely transportable chapter.

- 11.1 Alkanes
 - A Closer Look: Writing Formulas and Drawing Structures
 - A Closer Look: Naming Alkanes
- 11.2 Alkenes and Alkynes
- 11.3 Aromatic Compounds
 - A Closer Look: Bonding in Benzene
- 11.4 Alcohols
 - Current Issues in Chemistry: New Life for Natural Gas
- 11.5 Compounds with a Carbonyl Group
 - A Closer Look: Muscle Cramps and Hangovers
- 11.6 Fats and Oils
- 11.7 Amines and Amides
- 11.8 Synthetic Organic Polymers

INTERVIEW: JEANETTE GRASSELLI BROWN

Jeanette Grasselli Brown is one of the world's foremost authorities in the field of infrared spectroscopy. She was the Director of Corporate Research for BP America. She received the Garvan Medal of the American Chemical Society in 1986 and the ACS Award in Analytical Chemistry in 1993.

CHAPTER 12 GASES AND THEIR PROPERTIES

- 12.1 The Properties of Gases
 - A Closer Look: Measuring Gas Pressure
- 12.2 The Gas Laws: The Experimental Basis
 - Portrait of a Scientist: Robert Boyle
 - Portrait of a Scientist: Jacques Alexandre Cesar Charles
 - Portrait of a Scientist: Joseph Gay-Lussac
- 12.3 The Ideal Gas Law
 - Problem Solving Tips and Ideas 12.1: Units and the General Gas Law
- 12.4 The Gas Laws and Chemical Reactions
- 12.5 Gas Mixtures and Partial Pressures
- 12.6 Kinetic Molecular Theory of Gases
- 12.7 Diffusion and Effusion
- 12.8 Some Applications of the Gas Laws and Kinetic Molecular Theory

New section applies the principles of gas laws to real-world scenarios such as deep sea diving.

- 12.9 Non-Ideal Behavior: Real Gases

CHAPTER 13 BONDING AND MOLECULAR STRUCTURE: INTERMOLECULAR FORCES, LIQUIDS, AND SOLIDS

- 13.1 Phases of Matter and the Kinetic Molecular Theory
- 13.2 Intermolecular Forces
 - Current Issues in Chemistry: Watery Cages
 - Current Issues in Chemistry: Molecular Self-Assembly
- 13.3 Properties of Liquids
 - Current Issues in Chemistry: Supercritical Gas Used in Cleaner Manufacture of Plastics
- 13.4 Metallic and Ionic Solids
 - A Closer Look: Packing Atoms and Ions into Unit Cells
 - Problem Solving Tips and Ideas 13.1: Unit Cells and Chemical Formulas
 - Problem Solving Tips and Ideas 13.2: Unit Cell Parameters and Density
 - A Closer Look: Using X-rays to Determine Crystal Structure
 - Portrait of a Scientist: Dorothy Crowfoot Hodgkin
- 13.5 Molecular and Network Solids
- 13.6 The Physical Properties of Solids

- 13.7 Changes in Structure and Phase

CHAPTER 14 SOLUTIONS AND THEIR BEHAVIOR

- 14.1 Units of Concentration
- 14.2 The Solution Process
- 14.3 Colligative Properties
 - Problem Solving Tips and Ideas 14.1: Using Colligative Properties to Determine Molar Masses
 - Current Issues in Chemistry: Survival at Sea
- 14.4 Colloids

CHAPTER 15 PRINCIPLES OF REACTIVITY: CHEMICAL KINETICS

- 15.1 Rates of Chemical Reactions
- 15.2 Reaction Conditions and Reaction Rate
- 15.3 Effect of Concentrations on Reaction Rate
- 15.4 Relationships Between Concentration and Time
 - Problem Solving Tips and Ideas 15.1: Using Logarithms and Your Calculator
 - A Closer Look: Half-Life and Reaction Orders
- 15.5 A Microscopic View of Reactions
- 15.6 Reaction Mechanisms
 - Problem Solving Tips and Ideas 15.2: A Summary of the Principles of Rate Equations and Reaction Mechanisms
- 15.7 Catalysts and Reaction Rate
 - Current Issues in Chemistry: Depletion of Stratospheric Ozone

CHAPTER 16 PRINCIPLES OF REACTIVITY: CHEMICAL EQUILIBRIA

- 16.1 The Nature of the Equilibrium State
- 16.2 The Equilibrium Constant
 - A Closer Look: Equilibrium Constant Expressions for Gases - K_c and K_p
 - Problem Solving Tips and Ideas 16.2: Writing and Manipulating Equilibrium Constant Expressions
- 16.3 The Reaction Quotient
- 16.4 Calculating an Equilibrium Constant
- 16.5 Using Equilibrium Constants in Calculations
 - Problem Solving Tips and Ideas 16.3: How to Assign the Unknown X
- 16.6 Disturbing a Chemical Equilibrium: Le Chatelier's Principle
- Table 16.2, "Effects of Disturbances on Equilibrium and K," summarizes the more conceptual considerations of Le Chatelier's principle and the factors that affect equilibrium conditions.*
- 16.7 Equilibrium, Kinetics, and Reaction Mechanisms
 - A Closer Look: Eating, Equilibrium, and Kinetics
- 16.8 Is There Life After Equilibrium?

A new section prepares students for later coverage of acid-base and precipitation chemistry, as well as thermodynamics and electrochemistry.

CHAPTER 17 PRINCIPLES OF REACTIVITY: THE CHEMISTRY OF ACIDS AND BASES

- 17.1 Water, The Hydronium Ion, and Autoionization
- 17.2 The Brønsted Concept of Acids and Bases
 - Problem Solving Tips and Ideas 17.1: Strong or Weak?
- 17.3 Water and the pH Scale
 - Problem Solving Tips and Ideas 17.2: Calculating and Using pH
- 17.4 Strong Acids and Bases
 - Current Issues in Chemistry: Sulfuric Acid - A Gauge of Business Conditions
- 17.5 Weak Acids and Bases
- 17.6 Ionization Constants For Weak Acids and Bases
 - Problem Solving Tips and Ideas 17.3: Using K_a and K_b
 - A Closer Look: Stomach Acidity or "I Ate Too Much!"
- 17.7 Acid-Base Properties of Salts: Hydrolysis

- 17.8 Polyprotic Acids
• Problem Solving Tips and Ideas 17.4: Polyprotic Acids
- 17.9 The Lewis Concept of Acids and Bases
- 17.10 Molecular Structure and Bonding and Acid-Base Behavior
A new section connects the structure of a compound, its ability to function as an acid, and the relative strengths of acids.

CHAPTER 18 PRINCIPLES OF REACTIVITY: REACTIONS BETWEEN ACIDS AND BASES

- 18.1 Acid-Base Reactions
• Problem Solving Tips and Ideas 18.1: The pH of the Solution at the Equivalence Point of an Acid-Base Reaction
- 18.2 The Common Ion Effect
• Problem Solving Tips and Ideas 18.2: Solving Common Ion Problems
- 18.3 Buffer Solutions
A new section dedicated to the discussion of buffers introduces The Henderson-Hasselbach Equation.
• Problem Solving Tips and Ideas 18.3: The pH of a Buffer Solution
- 18.4 Acid-Base Titration Curves
• Problem Solving Tips and Ideas 18.4: Calculating the pH at Various Stages of an Acid-Base Reaction
- 18.5 Acid-Base Indicators

CHAPTER 19 PRINCIPLES OF REACTIVITY: PRECIPITATION REACTIONS

- 19.1 The Solubility Product Constant, K_{sp}
- 19.2 Determining K_{sp} from Experimental Measurements
- 19.3 Estimating Salt Solubility from K_{sp}
• Problem Solving Tips and Ideas 19.1: Seeing Double?
- 19.4 Precipitation of Insoluble Salts
• Problem Solving Tips and Ideas 19.2: Will a Precipitate Form?
- 19.5 Solubility and the Common Ion Effect
• Problem Solving Tips and Ideas 19.3: Solubility in the Presence of a Common Ion
- 19.6 Solubility, Ion Separations, and Qualitative Analysis
- 19.7 Simultaneous Equilibria
- 19.8 Solubility and pH
- 19.9 Solubility and Complex Ions
- 19.10 Equilibria in the Environment: Carbon Dioxide and Carbonates
- 19.11 Chemical Equilibria: An Epilogue

CHAPTER 20 PRINCIPLES OF REACTIVITY: ENTROPY AND FREE ENERGY

- 20.1 Speed and Product-Favored Reactions
- 20.2 Energy and Product-Favored Reactions
- 20.3 Spontaneity, Disorder, and Entropy
- 20.4 Entropy, Elements, and Compounds
- 20.5 Entropy and the Second Law
- 20.6 Thermodynamics and the Equilibrium Constant
- 20.7 Thermodynamics and Time

CHAPTER 21 PRINCIPLES OF REACTIVITY: ELECTRON-TRANSFER REACTIONS

- 21.1 Writing Balanced Equations for Electron-Transfer Reactions
- 21.2 Chemical Change and Electric Current
- 21.3 Electrochemical Cells and Potentials
- 21.4 What Happens at Nonstandard Conditions
- 21.5 Electrolysis: Chemical Change from Electrical Energy
- 21.6 Electrical Energy
- 21.7 Commercial Production of Chemicals by Electron-Transfer Reactions
- 21.8 Corrosion

CHAPTER 22 CHEMISTRY OF THE MAIN GROUP ELEMENTS

This is a condensation of Chapters 22-24 in the second edition of Chemistry and Chemical Reactivity, 3/e.

- 22.1 The Periodic Table, A Guide to the Elements
• Valence Electrons
• Ionic Compounds of Main Group Elements
• Covalent Compounds and Electron Configurations
• What Exists? What Doesn't Exist?
- 22.2 Hydrogen
• Preparation of Hydrogen
• Chemical and Physical Properties of Hydrogen
• Uses of Hydrogen
- 22.3 Sodium and Potassium
• Preparation and Properties
• Sodium Compounds of Commercial Importance
- 22.4 Magnesium and Calcium
• Properties of Calcium and Magnesium
• Metallurgy of Magnesium
• Calcium Compounds of Commercial Importance
- 22.5 Aluminum
• Properties of Aluminum and Its Compounds
• Metallurgy of Aluminum
- 22.6 Silicon
• Silicon Dioxide
• The Silicate Minerals
- 22.7 Nitrogen and Phosphorus
• The Elements: Nitrogen and Phosphorus
• Ammonia and Nitrogen Fixation
• Nitrogen Compounds
- 22.8 Oxygen and Sulfur
• Preparations and Properties of the Elements
• Compounds of Sulfur
- 22.9 Chlorine
• Chlorine Compounds

CHAPTER 23 CHEMISTRY OF THE TRANSITION ELEMENTS

- 23.1 Properties of the Transition Elements
- 23.2 Commercial Production of Transition Metals
- 23.3 Coordination Compounds
- 23.4 Structures of Coordination Compounds and Isomers
- 23.5 Bonding in Coordination Compounds
- 23.6 The Colors of Coordination Compounds

INTERVIEW: DARLEANE C. HOFFMAN (tentative)

Dr. Hoffman is a professor of chemistry at University of California, Berkeley. She is the leader of the heavy element and radiochemistry group at Lawrence Berkeley Laboratory and is Director of the Glenn T. Seaborg Institute for Transactinium Science. She received the ACS Award in Nuclear Chemistry in 1983 and the Garvan Medal in 1990. In this interview she discusses the ongoing controversy over the names of the heaviest elements and describes the discovery of element 110.

CHAPTER 24 NUCLEAR CHEMISTRY

- 24.1 The Nature of Radioactivity
- 24.2 Nuclear Reactions
- 24.3 Stability of Atomic Nuclei
- 24.4 Rates of Disintegration Reactions
- 24.5 Artificial Transformations
• A Closer Look: A Revision to the Periodic Table
• Portrait of a Scientist: Glenn Seaborg and the Transuranium Elements
• Current Issues in Chemistry: Protect Your Home With a Smoke Detector
- 24.6 Nuclear Fission
- 24.7 Nuclear Fusion
- 24.8 Radiation Effects and Units of Radiation
- 24.9 Applications of Radioactivity
• Current Issues in Chemistry: Assessing Your Exposure to Radiation

Pocket Guide John DeKorte, *Glendale Community College* contains useful summaries of each text section as well as helpful problem-solving reminders and tips. The pocket guide, a \$15 value, is free upon adoption.

Cambridge Scientific ChemDraw and Chem3D are software packages that enable students to draw molecular structures. Users draw with ChemDraw; they can then transfer their work into Chem3D, which allows them to create and manipulate three-dimensional color models for a sharper image of a molecule's shape and reaction sites. Cambridge Scientific provides an accompanying User's Guide and Quick Reference Card, written exclusively for Saunders College Publishing. Available shrinkwrapped with the text at a nominal fee.

Study Guide Harry Pence, *SUNY, Oneonta* has been developed to incorporate key objectives in the text and contains a list of main concepts, important terms, questions about the objectives, chapter test, and a set of comprehensive questions.

Student Solutions Manual Alton Banks, *North Carolina State University* includes problem-solving strategies and detailed solutions to selected end-of-chapter questions.

Instructor's Resource Manual suggests alternative organizations for the course, classroom demonstrations, and worked-out solutions to questions not designated by a blue number in the text.

The Use of Estimates in Solving Chemistry Problems, 2/e by Michael Green and Denise Garland, both of *The City College of the City University of NY*, is designed to help students gain a feel for chemistry by first solving problems approximately, and getting past the memorization of formulas.

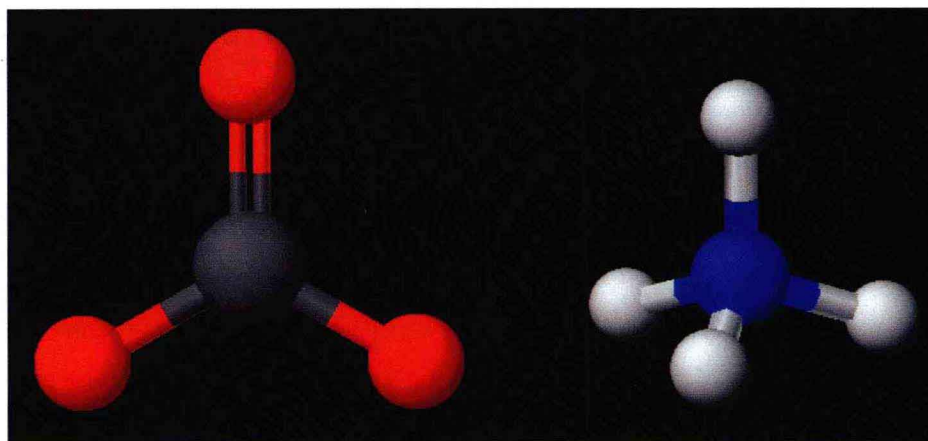
Test Bank Karen Eichstadt, *Ohio University* provides instructors with more than 1100 multiple-choice and fill-in printed test questions.

ExaMaster+™ Computerized Test Bank is a software version of the printed Test Bank, complete with the same capabilities, enabling instructors to add to or edit problems to create their own tests. Available in IBM and Macintosh formats.

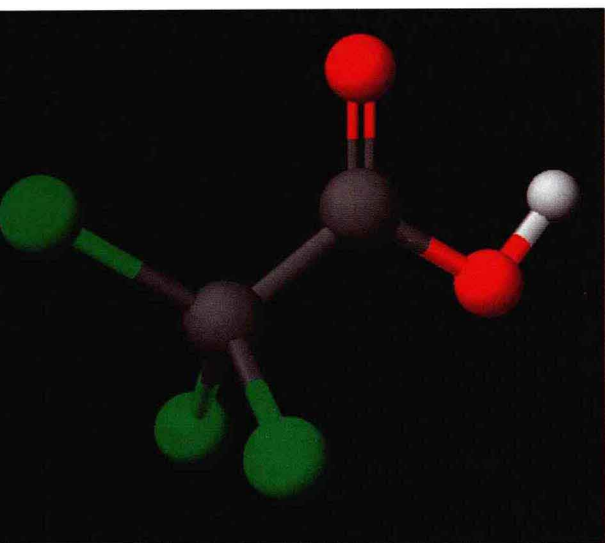
Overhead Transparency Acetates include 150 full-color transparency acetates, all with large labels for easy classroom viewing.

Chemical Principles in the Laboratory, 6/e by Emil Slowinski and Wayne Wolsey, both of *Macalester College*, and William Masterton, *University of Connecticut*, is a new edition for 1996, (available June 1995) which contains 42 experiments, including 3 new ones. It is the most widely-used general chemistry Lab Manual in the industry.

Instructor's Manual to accompany **Lab Manual** provides lists of equipment and chemicals needed for each experiment.



Computer-generated models of the carbonate ion, CO_3^{2-} (left) and the ammonium ion, NH_4^+ (right). The colors are C=gray, O=red, N=blue, and H=white.



A computer-generated model of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$. The C atoms are gray, the H atoms are white, and the O atom is red.

Chemistry of Life Videodisc contains over 100 molecular model animations, chemical reaction videos and approximately 2,500 still images from a variety of Saunders general chemistry texts.

LectureActive™ Software comprises all video clip and still images from the General Chemistry Videodisc, allowing instructors to create custom lectures quickly and easily. Lectures can be read from the computer screen or printed with barcodes for all Videodisc instructions. Available for Macintosh and IBM formats.

Shakhashiri Demonstration Videotapes feature well-known instructor Bassam Shakhashiri, *University of Wisconsin*, performing 50 3 to 5-minute chemistry demonstrations. An accompanying **Instructor's Manual** describes each demonstration and includes discussion questions.

Shakhashiri Audiotapes serve as self-tutorials and are accompanied by a workbook.

KC? Discoverer Software (JCE: Software), developed by a team of chemistry experts, explores 48 numerical properties of the elements, such as atomic radii, density, and ionization energy; non-numerical information is included, too, such as color, reactivity with air, water, and acids and bases. The **HELP** menu provides a reference for the source of data for each of the properties and the database. KC? Discoverer Software has the capability to correlate with the Periodic Table Videodisc. Available to qualified adopters.

Periodic Table Videodisc: Reactions of the Elements (JCE: Software) Alton J. Banks, *North Carolina State University* features still and live footage of the elements, their uses, and their reaction with air, water, acids, and bases. Users operate the videodisc from a videodisc player with a hand-controlled keypad, a barcode reader, or an interface to a computer running KC? Discoverer Software. Available to qualified adopters.

Barcode Manual for Saunders Videodisc contains complete descriptions, barcode labels, and reference numbers for every still image and video clip. The Manual also offers practical advice about the General Chemistry Videodisc, such as set-up instructions for first-time users.

World of Chemistry Videotapes, taken from the popular PBS television series and hosted by Nobel laureate Roald Hoffmann, are two 40-minute videos highlighting topics such as the mole, bonding, and acid-base chemistry and their applications. Order through the Annenberg Foundation at 1-800-LEARNER.

Chemistry in Perspective Videodisc available January 1996.

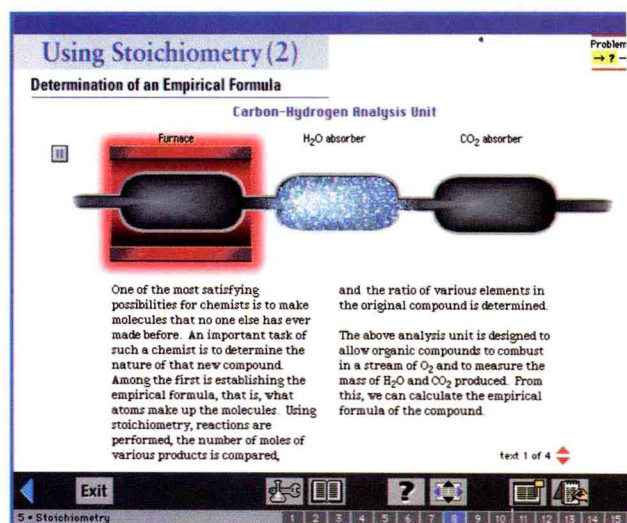
Designed exclusively for Saunders College Publishing by Archipelago Productions, and authored by Jack Kotz of *SUNY-Oneonta* and Bill Vining of *Hartwick College*. The new CD-ROM for General Chemistry is a revolutionary interactive tool. A stand alone, multimedia presentation of *Chemistry and Chemical Reactivity, 3/e*.

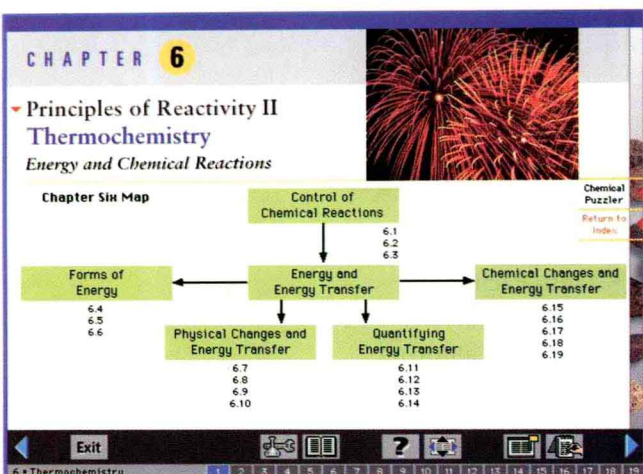
The CD-ROM serves as an alternative or companion to the text. *Chemistry and Chemical Reactivity, 3/e* appears in its entirety on the CD-ROM. Based on *Chemistry and Chemical Reactivity, 3/e*, and including the text in its entirety, the CD-ROM serves as a useful multimedia companion to the text or can be used as an alternative to *Chemistry and Chemical Reactivity, 3/e*.

With the vast capabilities of the CD-ROM, students are able to approach chemistry using imaginative, innovative methods. Most important, the CD-ROM gives students the opportunity to be independent thinkers through interactive techniques.

The CD-ROM is divided into chapters. The chapters are displayed on screens. Each screen presents an idea or concept and allows the user to interact with the material in one of several ways:

- ▶ Watch a reaction in process.
- ▶ Change a variable in an experiment and watch what happens.
- ▶ Listen to tips and suggestions for understanding concepts or solving problems.





Each chapter begins with questions. Students find the answers to these questions as they navigate through the CD-ROM, using these features:

- ▶ Original animation and graphics that illustrate chemical concepts
- ▶ Interactive tools that simulate real chemical experiments on the computer
- ▶ Problems and their step-by-step solutions, with helpful hints from a narrator
- ▶ Pop-up definitions for difficult terms and equations
- ▶ More than 100 video clips demonstrating chemical experiments, enhanced by sound effects and narration
- ▶ More than 100 chemical molecular models and animations

Related material from *Chemistry and Chemical Reactivity, 3/e*, can be accessed from any screen, enabling students to refer to the text as they move through the CD-ROM chapters.

At the end of each chapter, students return to the original questions and are able to apply the chemical principles learned while using the CD-ROM.



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 St. College, WV

John C. Kotz received his Ph.D. from *Cornell University* in 1964 and currently teaches chemistry at the *SUNY College at Oneonta*, where he was promoted to University Distinguished Teaching Professor in 1986. In 1979, he was a Fulbright Lecturer and Research Scholar in Lisbon, Portugal. He has received the National Catalyst Award in Chemical Education from the Chemical Manufacturers Association. Dr. Kotz is an editor of *Chem Matters* magazine and is on the board of editors of the *Journal of Chemical Education: Software*. He is also the coauthor of two inorganic chemistry textbooks and another Saunders introductory general chemistry text, *The Chemical World: Concepts and Applications*.

Paul Treichel, Jr., received a B.S. from the *University of Wisconsin-Madison* in 1958 and a Ph.D. from *Harvard University* in 1962. After a year of postdoctoral study at *Queen Mary College* in London, he assumed a faculty position at the *University of Wisconsin-Madison*, where he has taught general and inorganic chemistry for 32 years and served as Department Chair since 1986. Treichel's research in organometallic chemistry, aided by 75 graduate and undergraduate students, has resulted in the publication of more than 160 articles in scientific journals.